Investigations into the Role of Weeds, Soil and Plant Debris in the Epidemiology of Foliar Fungal Diseases of Yam in Western Nigeria

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Abstract: The role of weeds, soil and plant debris in the epidemiology of foliar diseases of yam was investigated at Ibadan Western Nigeria in the lowland humid tropics. Sclerotium rolfsii, Colletotrichum gloeosporioides, Colletotrichum graminicola, Pestalotia sp., Curvularia lunata, Curvularia eragrostidis, Drechslera sp. and Rhizoctonia solani, fungi that can be pathogenic on yam (Dioscorea alata) were isolated from weeds in the vicinity of the yam plots. Plant debris found with the yam plots also contained Sclerotium rolfsii, Colletotrichum gloeosporioides and Rhizoctonia solani. High inoculum densities of 4.61±0.36x10⁶ cfu g⁻¹ of S. rolfsii, 3.22±0.14x10⁵ cfu g⁻¹ of R. solani and 4.32±0.39x10⁶ cfu g⁻¹ of C. gloeosporioides were recorded in soil obtained from yam fields that were manually weeded 3 times during the experimental period. Soil samples in yam plots that were manually weeded 3 times and those yam plots prepared by clearing and burning the debris in situ, had varying inoculum densities of these pathogens. On yam fields with burnt debris, the incidence of Sclerotium leaf blight, Rhizoctonia leaf blight, Curvularia leaf spot and Pestalotia leaf spot were lower than those recorded after other treatments. In fields with burnt debris, the incidence of anthracnose from C. gloeosporioides was 26.9%, while in yam fields that were weeded free and those that were manually weeded 3 times, the incidence of the anthracnose disease was 45.3 and 65.7%, respectively.

Key words: Weeds, plant debris, soil, foliar diseases, Dioscorea sp., epidemiology, pathogen

INTRODUCTION

Yam (Dioscorea sp.) is one of the staple foods in the tropics and other parts of the world. West Africa produces about 90-95% of the world yam production of which 71% is grown in Nigeria.[1] As of 1997, the annual production of yam in Nigeria was estimated at 23.9 million tons.[2] Dioscorea sp. are grown mainly in the rainy season, which makes the crop susceptible to diseases, weeds and pest attack. Foliar diseases of yam have been reported as one of the major constraints of production in Nigeria[3] and yam anthracnose caused by Colletotrichum gloeosporioides has been reported to cause losses in excess of 90%.[4] Amusa et al.[5] reported the occurrence of 11 different foliar pathogens of yam in south-western Nigeria. The role of some of these pathogens either alone or in combination with others has been reported.[6-9]

Weeds have been reported to cause a reduction of about 73% yield in yam.[10] Akobundu[11] showed that these losses were both direct (reductions in growth, stand and tuber dry weight) and indirect (i.e. damage caused by other pests that use weeds as alternate hosts). However, in Nigeria there is little or no information on the roles played by weeds, soil and plant debris in the foliar disease development in yam. This study was undertaken to investigate the role played by weeds, soil and plant debris in the epidemiology of foliar diseases of yam at Ibadan in the lowland humid tropics.

MATERIALS AND METHODS

Field plots were located in the yam experimental fields of the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, which lies within the lowland humid rain-forest zone. The mean annual rainfall of 1150-1500 mm occurs mainly between April and October with the major peak in June. Higher relative humidity values (80-95%) are recorded during the rainy season than the dry season (20-50%). The field used for the experiment was prepared by bush clearing using cutlasses followed by heap moulding using hoes typical of local yam producers in south-western Nigeria. The yam minisetts used was D. alata, which is mostly cultivated in south-western Nigeria and was planted in mid March 1999 and 2000. Three field treatment
were used, an initial treatment with a pre-emergence herbicide (Atrazine, 2.5 kg ai ha\(^{-1}\)) and repeated manually hoeing, manually weeding three times during the period of the experiment and the use of yam plots prepared by clearing and burning the debris in situ. Each yam plot was 10x8 m and each treatment included three rows replicated three times. Sixty-three plants were planted per plot, with each yam set planted 1 within and between rows; 1x1 m of the yam plot was used as border rows. The incidence and severity of foliar diseases were determined in each of the experimental fields\(^{[1,2]}\).

Weed plants within a 5 m radius around the experimental plots showing leaf spot and leaf blight disease symptoms were collected. The infected portions were excised, cut into 2 mm pieces and surface sterilized with 0.524% (w/v) sodium hypochlorite for 30 sec and rinsed in 4 successive changes of sterile water. Samples were plated on acidified potato dextrose agar (APDA) acidified with 0.2 N HCl and incubated for 6 days at 26°C under a 12 h photoperiod. The pathogens were identified by microscopic examination\(^{[13]}\) and also by comparison with standard isolates obtained from the yam pathology laboratory ITA, Ibadan, Nigeria, which had been previously identified at CABl Biosciences Egham, UK.

One gram of soil samples obtained from each of the treatments were placed in 9 mL of sterile distilled water vigorously shaken on a whirlimixer for 10 min and serially diluted to 10\(^{-1}\) g after which 1 mL of the 10\(^{-1}\) to 10\(^{-4}\) suspensions was plated on APDA. The plates were incubated for 6 days at 26°C and pathogens identified by microscopic examination by Barnett and Hunter\(^{[14]}\). Plate counts (colony forming units-cfu) were used to determine the inoculum load or population of the pathogens in the soil. The experiment was conducted in the 1999 and 2000 planting season.

Pathogenicity of the isolates: Eight-week-old seedlings of the tropical Dioscorea alata (TDa) grown in non-sterile soil contained in 15 cm-diameter plastic pots were inoculated by spraying to run off with a mycelial suspension at an inoculum density of 2.4x10\(^{9}\) colony forming units (cfu) of each of the isolates on the leaflets using a master hand sprayer. The mycelial suspension was obtained by culturing the fungal isolates in potato dextrose broth in 100 mL conical flasks. The mycelial mats were harvested and blended in a Waring blender and diluted to a desired concentration. Plate counts were used to determine the inoculum load of each isolate. A drop of Tween 80 80 L\(^{-1}\) of inoculum was added to the mycelia suspension as a wetting agent. The control plants were sprayed with sterile distilled water. Six potted yam plants/per treatment were replicated three times in a complete randomised block design. The isolated fungi which includes Sclerotium rolfsii, Colletotrichum gloeosporioides, C. graminicola, Pestalotia sp., Curvularia lunata, C. eragrostidis, Drechslera sp., Pestalotia sp., Fusarium sp. and Rhizoctonia solani, were tested, each isolate considered as a single treatment. The inoculated and control plants were incubated for 48 h in transparent polyethylene bags in a moist chamber at 80-85% relative humidity and 22-25°C. The plants were then placed on the greenhouse bench and observed for wilting, leaf spot and blight disease symptoms. The pathogens were later isolated from yam plants showing symptoms of infection and compared with the initial isolates.

RESULTS

Ten fungi potentially pathogenic to yam were isolated from fourteen weed species were found to harbor (Table 1). The most prevalent fungi were Colletotrichum gloeosporioides, C. graminicola, Curvularia sp. and S. rolfsii, S. rolfsii, Curvularia sp. and Rhizoctonia solani were isolated from yam debris. The soil assay contained S. rolfsii at the highest inoculum loads of 4.61±0.36x10\(^{9}\) cfu g\(^{-1}\) of soil in yam fields weeded 3 times. In comparison, inoculum load of 0.03±0.002x10\(^{9}\) cfu g\(^{-1}\) of soil and 4.46±0.42x10\(^{9}\) cfug\(^{-1}\) of S. rolfsii were found in yam fields with burnt debris and weed free plots, respectively (Table 3). Inoculum loads of R. solani and C. gloeosporioides in yam plots weeded 3 times were 3.2±0.1x10\(^{9}\) cfu g\(^{-1}\) of soil and 3.32±0.3x10\(^{9}\) cfug\(^{-1}\) of soil, respectively. In yam plots with burnt debris the inoculum densities of R. solani and C. gloeosporioides were 0.08±0.0041x10\(^{9}\) soils and 4.46±0.421x10\(^{9}\) cfu g\(^{-1}\) and 0.15±0.003x10\(^{9}\) soil and 3.62±0.25x10\(^{9}\) cfug\(^{-1}\) of soil in weed free plots soil. The inoculum densities of Curvularia sp. and Pestalotia sp. in soil obtained from yam plots are shown in Table 3.

In the pathogenicity test S. rolfsii induced circular leaf spots of various sizes that formed in concentric rings on the test plants, while Pestalotia sp. caused dark brownish spots with a reddish border. R. solani induced stem blackening and stem tip die back on mature plants, black spots on juvenile leaves and brown water-soaked leaf spots on mature leaves. C. gloeosporioides produced small brown spots which eventually enlarged and spread, ultimately affecting a large proportion of the foliage, the petioles and the stem by Curvularia sp. induced circular leaf spots.

The field disease score, for the incidence of anthracnose induced by C. gloeosporioides was 26.9%, in fields with burnt debris, while in yam fields that were
Table 1. Survey of weeds and the associated fungal pathogens in yam (D. alata) plots

<table>
<thead>
<tr>
<th>Weed plants</th>
<th>C. graminicola</th>
<th>Rhizoctonia solani</th>
<th>Curvularia lunata</th>
<th>Colletotrichum gloeosporioides</th>
<th>C. odorata</th>
<th>D. solani</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asystasia gangetica</td>
<td>89</td>
<td>26</td>
<td>64</td>
<td>20</td>
<td>16</td>
<td>100</td>
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<tr>
<td>Acanthospermum ilicifolium</td>
<td>62</td>
<td>10</td>
<td>49</td>
<td>62</td>
<td>99</td>
<td>100</td>
</tr>
<tr>
<td>Chromolaena odoranta</td>
<td>20</td>
<td>20</td>
<td>100</td>
<td>64</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Commelina benghalensis</td>
<td></td>
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<td>20</td>
<td>20</td>
<td>20</td>
<td>100</td>
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<tr>
<td>Commelina erecta</td>
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<td>20</td>
<td>100</td>
<td>20</td>
<td>20</td>
<td>100</td>
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<tr>
<td>Euphorbia characias</td>
<td>42</td>
<td>18</td>
<td>18</td>
<td>42</td>
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<td>18</td>
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<tr>
<td>Euphorbia helioscopia</td>
<td></td>
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<td>Ipomoea alata</td>
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<td>Ipomoea involucrata</td>
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<td>Ipomoea triloba</td>
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<td>20</td>
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<tr>
<td>Manchurian pennoncio</td>
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<td>40</td>
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<tr>
<td>Pavetta maximus</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Spatholobus nodiflorus</td>
<td></td>
<td></td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 2. The incidence (%) and severity of fungal diseases of yam (D. alata) in three experimental plots

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Anthracnosa (Incidence)</th>
<th>Sclerotium leaf spot (Incidence)</th>
<th>Rhizoctonia leaf blight (Incidence)</th>
<th>Curvularia leaf spot (Incidence)</th>
<th>Pestalotia leaf spot (Incidence)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Incidence</td>
<td>severity</td>
<td>Incidence</td>
<td>severity</td>
<td>Incidence</td>
</tr>
<tr>
<td>Weed free</td>
<td>42.16%</td>
<td>3.41%</td>
<td>21.65%</td>
<td>3.29%</td>
<td>12.14%</td>
</tr>
<tr>
<td>Weeded three times</td>
<td>65.72%</td>
<td>3.73%</td>
<td>31.18%</td>
<td>3.56%</td>
<td>16.15%</td>
</tr>
<tr>
<td>Burnt debris</td>
<td>26.95%</td>
<td>2.24%</td>
<td>12.32%</td>
<td>2.11%</td>
<td>8.17%</td>
</tr>
</tbody>
</table>

Means followed by the same letter are not significantly different at p < 0.05%

Table 3. The frequency of fungal pathogens associated with yam diseases in cultivated soils

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Anthracnosa (Incidence)</th>
<th>Sclerotium leaf spot (Incidence)</th>
<th>Rhizoctonia leaf blight (Incidence)</th>
<th>Curvularia leaf spot (Incidence)</th>
<th>Pestalotia leaf spot (Incidence)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. graminicola</td>
<td>0.00400 000 Χ10⁻⁴</td>
<td>4.12x 0.39 Χ10⁻⁴</td>
<td>3.46x 0.37 Χ10⁻⁴</td>
<td>3.46x 0.42 Χ10⁻⁴</td>
<td>3.46x 0.42 Χ10⁻⁴</td>
</tr>
<tr>
<td>Sclerotium rolfsii</td>
<td>0.0360 000 Χ10⁻⁴</td>
<td>4.12x 0.39 Χ10⁻⁴</td>
<td>4.12x 0.39 Χ10⁻⁴</td>
<td>4.12x 0.39 Χ10⁻⁴</td>
<td>4.12x 0.39 Χ10⁻⁴</td>
</tr>
<tr>
<td>Rhizoctonia solani</td>
<td>0.1360 000 Χ10⁻⁴</td>
<td>3.22x 0.14 Χ10⁻⁴</td>
<td>3.22x 0.14 Χ10⁻⁴</td>
<td>3.22x 0.14 Χ10⁻⁴</td>
<td>3.22x 0.14 Χ10⁻⁴</td>
</tr>
<tr>
<td>Curvularia lunata</td>
<td>0.1360 000 Χ10⁻⁴</td>
<td>3.22x 0.14 Χ10⁻⁴</td>
<td>3.22x 0.14 Χ10⁻⁴</td>
<td>3.22x 0.14 Χ10⁻⁴</td>
<td>3.22x 0.14 Χ10⁻⁴</td>
</tr>
<tr>
<td>Pestalotia sp.</td>
<td>0.0360 000 Χ10⁻⁴</td>
<td>1.05x 0.09 Χ10⁻⁴</td>
<td>1.05x 0.09 Χ10⁻⁴</td>
<td>1.05x 0.09 Χ10⁻⁴</td>
<td>1.05x 0.09 Χ10⁻⁴</td>
</tr>
<tr>
<td>Curvularia sp.</td>
<td>0.1360 000 Χ10⁻⁴</td>
<td>3.22x 0.14 Χ10⁻⁴</td>
<td>3.22x 0.14 Χ10⁻⁴</td>
<td>3.22x 0.14 Χ10⁻⁴</td>
<td>3.22x 0.14 Χ10⁻⁴</td>
</tr>
</tbody>
</table>

* Standard deviation

Discussion

Most of the fungi isolated from the weeds plants were potentially pathogenic on yam. This supports the earlier report by Emu et al. on leaf spot- inducing fungi on yam. Amusa et al. also reported the occurrence of C. gloeosporioides, C. graminicola, S. rolfsii, Pestalotia sp., Botryodiplodia theobromae, Curvularia pallescens, C. eragrostidis, R. solani and F. oxysporum in leaf spot diseases of cultivated yam in western Nigeria. Colletotrichum gloeosporioides, the causal agent of yam anthracnose, has been reported to cause losses in excess of 99%. This pathogen was also found in this study associated with Commelina beghensis, Chromoleana odorontia, Acalypha ciliata, Centrosema pubescens and Acantho spernum insipidum, all were weeds commonly encountered in yam fields in western Nigeria. Chromoleana odorontia, Syndrella nodiflora and Ipomoea sp. have previously been associated with C. gloeosporioides and S. rolfsii in yam fields. Colletotrichum gloeosporioides is probably the most ubiquitous of all Colletotrichum sp. and has been recorded from a wide range of hosts. Although wet conditions and susceptibility of host tissue at the time of infection are necessary for disease development, the ability of the fungus to survive in hosts when the environmental conditions are unfavorable enables the pathogen to overwinter between the susceptible stages of the cropping cycle.

Curvularia lunata and Colletotrichum graminicola were isolated from the grasses Panicum maximum and Cynodon dactylon. These fungi are known to produce phyto-toxic metabolites and induce necrotic lesions on yam plants. Amusa et al. reported that both Colletotrichum graminicola and Curvularia lunata are likely to be transient organism on yam and that they probably overwinter in necrotic lesions on the crop induced by other pathogens.

The results of this study showed that in yam fields where debris was burnt in situ inoculum densities were lower compared to those of other treatments. This supports the view that some pathogens of tuber root crops survive in plant debris. The most prevalent pathogen both the weeds and debris was S. rolfsii. This species has been reported to induce concentric leaf spots on yams and is regarded as one of the most important pathogens of yam causing serious damage to leaves and stems and can also induce rocks in tubers. When infected tubers are left on the surface of a field, numerous
REFERENCES


